



CBRN APR Respirator Concepts

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CBRN APR Respirator Concepts

Three Tiers of Requirements:

- 42 CFR, Part 84 – Applicable Sections
- Requirements Derived from other Standards/Specifications
- Special CBRN APR Requirements



CBRN APR Respirator Concepts

- Special CBRN APR Requirements
 - Systems CWA Penetration / Permeation
 - Laboratory Respiratory Protection Level
 - Gas Life Testing



CBRN APR – Hazard Analysis and Selection

- Initial vulnerability assessment list of chemical agent hazards identified potential respiratory hazards
- Classification of hazards into Agent Families
- Test Representative Agent (TRA) required for each family of agents.
- Back up data with other agents within family being generated.
- Biological and Radiological agents are addressed as particulates requiring P-100 media



Families / Test Representative Agents (TRA)

- **Acid Gas / TRA** = SO_2 , H_2S , CNCL , COCl_2 , HCN
- **Base Gas / TRA** = Ammonia
- **Hydrocarbon / TRA** = Cyclohexane
- **Hydrides / TRA** = Phosphine
- **Isocyanate / TRA** = TBD
- **Nitrogen Oxide / TRA** = NO_2
- **Particulate / TRA** = DOP
- **Formaldehyde / TRA** = Formaldehyde
- **Unknown /** further study required
- **Air Supplied** - Air Supplied respirators required



Testing of the TRA should provide protection for respirable Chemical agents **(105)**, plus Particulate Biological agents **(13)** & Particulate Radiological/Nuclear agents **(16)**:

- 61 Organic Vapor Family**, with vapor pressures less than that of Cyclohexane (TRA)
- 27 Acid Gas Family**, TRA's = Cyanogen Chloride, Phosgene, Hydrogen Cyanide, Hydrogen Sulfide, and Sulfur Dioxide
- 3 Base Gas Family**, TRA = Ammonia
- 4 Hydride Family**, TRA = Phosphine
- 6 Nitrogen Oxide Family**, TRA = Nitrogen Dioxide
- 1 Formaldehyde Family**, only member of family and is TRC
- 32 Particulate Family**, TRA = DOP

CBRN APR Test Challenge

Guidelines for determining test challenge concentrations:

1. (REL) X (Full Face APF) X (Safety Factor)
2. Set APF= 50
3. Set Safety Factor, S.F. = 2.0
4. Minimum Test Challenge = 3 X (IDLH)
5. Breakthru = (REL) / 2

Calculated Test Challenge

	REL	APF	S.F.	1. (REL) X (F.F. APF) X (SF)		IDLH	3(IDLH)		Test Conc. Initial	Brkthru Conc. Initial
Ammonia	25	50	2	2500		300	900		2500	12.5
Carbon Monoxide	35	50	2	3500		1200	3600		3600	17.5
Carbon Tetrachloride	2	50	2	200		200	600		600	1
Cyanogen Chloride	0.03	50	2	3		-----	----		3	0.02
Cyclohexane	300	50	2	30000		1300	3900		30000	150
Formaldehyde	1.5	50	2	150		20	60		150	0.016
Hydrogen Cyanide	4.7	50	2	470		50	150		470	2.35
Hydrogen Sulfide	10	50	2	1000		100	300		1000	5
Nitrogen Dioxide	1	50	2	100		20	60		100	0.5
Phosgene	0.2	50	2	20		2	6		20	0.1
Phosphine	0.3	50	2	30		50	150		150	0.15
Sulfur Dioxide	2	50	2	200		100	300		300	1

CBRN APR Concepts – Special Requirements /Background



➤ **Systems Permeation & Penetration Challenges**

Plausible incident scenarios were developed that consider possible venues (e.g., small room, large room, arena, open air areas) and dissemination devices for release of a CWA

Sarin (GB) and Sulfur Mustard (HD) were selected as the two representative agents for the penetration/permeation test.



CBRN Standard Development: SCBA CBRN Background

- Respirator systems are challenged with chemical warfare agents.
- Challenges are based on the Most Creditable Event indoor scenarios
- Sarin (**GB**) vapor challenge = 2000 mg/m³
- Distilled Sulfur Mustard (**HD**) vapor challenge = 300 mg/m³, liquid droplet challenge approximately 10 g/m³
- Breakthrough Values Set at 10 minute AEGL2 levels



CBRN Standard Development Special Requirements

Penetration/Permeation Systems Test For APRs – determination of a systems test concentration challenge:

- A calculated concentration based upon (1) single shift operation and (2) AEGL values were determined.
- A single shift of twelve hours was identified as the expected operational shift for a responder wearing an APR.
- The ten-minute AEGL2 value was selected as the basis for the challenge concentrations



CBRN Standards Development

- CBRN APR Live Agent Test (Smartman)
- Challenge Concentration
 - 1-Shift (12 Hour = Max. Dose)
 - AEGL 2 Mild Effects Limiting Exposure
 - Assigned Protection Factor (APF) = 50
 - Safety Factor
 - Applied Over 30 Minutes
- Max Dose =
 $(\text{AEGL 2}) \times (\text{APF}) \times (\text{SF}) \times (12 \text{ Hours}) \div (30)$



CBRN Standards Development

- CBRN APR GB Test Challenge:
 - $(.087) \times (50) \times (2) \times (720) \div (30) = 209$
 - 210 mg/m³ Used For Test Challenge

Test Conditions (3 tests with GB): 12 Hours---
30 minutes of exposure plus 690 minutes
observation of decay



CBRN Standard Development

CBRN APR HD Test Challenge:

- $(0.60) \times (50) \times (2) \times (720) \div (30) = 1440$
- $1440 \text{ mg} / \text{m}^3 > 300 \text{ mg}/\text{m}^3$ Credible Event
- $300 \text{ mg}/\text{m}^3$ Used For Test Challenge

Test Conditions (3 tests with HD): 12 Hours--- 30 minutes of exposure plus 690 minutes observation. of decay

- Liquid Droplets deposited at selected locations. Total Liquid concentration 0.43 - 0.86ml of HD per respirator.
- Vapor Challenge of $300\text{mg}/\text{m}^3$ of HD for 30 Minutes.



CBRN Standards Development

- CBRN APR Test Breakthrough(B_t)
- Accounts For Interoperability of Masks & Filters)

Respirator A (B_t) = Mask A (B_t) + Filter A (B_t) = T

Respirator B (B_t) = Mask B (B_t) + Filter B (B_t) = T

Where: T = Maximum Permissible Breakthrough

Set Worst Case: Mask A (B_t) = T and Filter B (B_t) = T

Therefore: Filter A (B_t) = 0 and Mask B (B_t) = 0

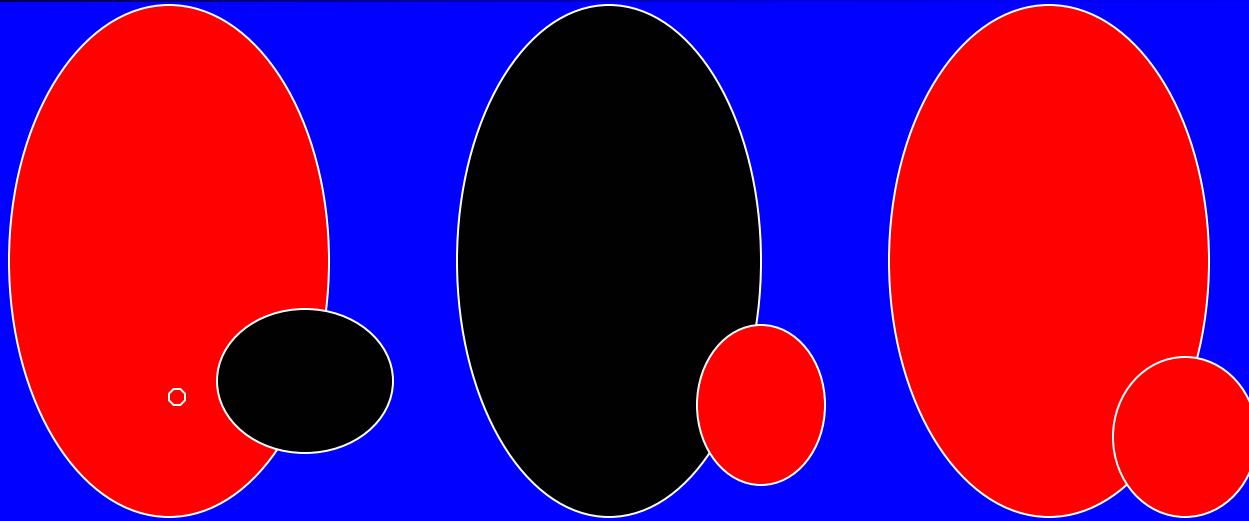
Thus,

Interchangeable Respirator (B_t) =

$$\text{Mask A } (B_t) + \text{Filter B } (B_t) = T + T = 2T$$



Breakthrough Concentrations



Red – Indicates Max Peak Breakthrough

Black – Indicates no Breakthrough

For GB: Max Peaks @ $.087 \text{ mg/m}^3 / 2 = .044 \text{ mg/m}^3$

For HD: Max Peaks @ $.6 \text{ mg/m}^3 / 2 = .3 \text{ mg/m}^3$



CBRN Standards Development

- CBRN Breakthrough Limits From SCBA
Agent Testing = Max. Permissible = $2T$
- CBRN APR Breakthrough = $T = (1/2) \text{ SCBA } B_t$

For GB: Max Peaks = $\frac{1}{2} (0.087) = 0.044 \text{ mg/m}^3$

Maximum Concentration = 1.05 mg/m^3

For HD: Max Peaks = $\frac{1}{2} (0.60) = 0.30 \text{ mg/m}^3$

Maximum Concentration = 3.0 mg/m^3



CBRN APR Concepts: Special Requirements / Laboratory Respiratory Protection Level

- Use procedures of the existing NIOSH STP Protocol (RCT-CBRN-STP-0202)
- Requirements Different from SCBA CBRN Protocol:
 - Measured protection level (2000) (SCBA CBRN measured protection level 500 when operated in a negative pressure mode)



CBRN Standards Development

- Questions?